Washington Navel Orange Juice

quality and mineral composition affected by chemical fertilizers, manure and covercrops

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The composition of Washington Navel orange juice is influenced by fertilizers, as shown in field experiments with Navels on sweet orange rootstock. Effects of nitrogen, phosphorus and potassium fertilizers—as well as manure and winter covercrops—were studied.

The first experiment is part of a complex, long-term trial in a thirty-year old grove located at Riverside, on Ramona loam soil. The second experimental grove is at Claremont, on Hanford gravelly loam. The grove is clean-cultivated, and the trees were approximately 50 years old when the observations were made.

The largest percentage of juice was produced by fruit from trees with the no-fertilizer treatment in the Riverside experiment, but the yields were much reduced by the lack of nitrogen.

Where the amounts of applied nitrogen were equal—three pounds N per tree per year—the plots which also used phosphorus produced fruit with slightly more juice. In the treatments without covercrop, the addition of phosphorus fertilizers increased the volume of juice 3.5%, while in those employing covercrops the increase was 7%.

The elimination of nitrogen fertilization resulted in an increase of 20.5% in juice content.

In both trials liberal applications of nitrogen had no effect on juice content, as compared with moderate applications. Manure, as compared with calcium nitrate as a source of nitrogen, also had no effect.

In the Claremont trials heavy phosphorus applications increased the volume of juice 9.4%. Manure increased the juice content slightly over that of the nitrogen treatment.

Potassium applications, or the growing of covercrops, apparently had no effect on the volume of juice of the fruit.

Acidity and Soluble Solids

Very low nitrogen treatments at Riverside resulted in a relatively low pH—pH-337—of the juice. Manure alone, and also high nitrogen, resulted in slightly higher pH—pH-3.49—of the juice. This relationship between high nitrogen and high pH has also been reported for grapefruit.

In each experiment the total acid—expressed as citric acid—of the juice tended to be reduced slightly where phosphorus was applied. At Riverside the reduction was from 1.05% to 1.01% and at Claremont from 1.40% to 1.13%. Where potassium was applied with phosphorus, the phosphorus apparently had no effect in lowering the juice acid. Application of potassium alone or with phosphorus, tended to increase the acid. Thus at Riverside the acid was increased from a low value of 1.05% to a high value of 1.17%.

At Claremont, nitrogen applications resulted in an increase of acid over the check treatment. Manure had no significant effect on acid in the Riverside experiment, but at Claremont it resulted in lower total acid than the nitrogen treatments.

In the Riverside experiments, soluble solids were not significantly changed by fertilizer applications in the noncovercropped plots. In the covercropped plots manure alone decreased soluble solids—13.47%—as compared to the average of plots receiving inorganic nitrogenous fertilizers—14.09%.

The values resulting from the use of manure alone were only slightly less than those obtained with fruit from the no-nitrogen treatments.

In the Claremont trials, phosphorus application gave somewhat lower soluble solids—13.73%—than the use of either nitrogen—14.41%—or potassium—14.23%—alone, or the application of nitrogen, phosphorus, and potassium—14.34%.

The ratio of soluble solids to acid in the fruit was lowered by the application of potassium at Riverside but not significantly affected at Claremont. The application of phosphorus tended toward a higher ratio at Riverside, and to a significantly higher ratio at Claremont.

Manure slightly decreased the ratio, in comparison with the nitrogen covercrop treatment at Riverside, and considerably decreased the ratio when compared with plots receiving high nitrogen from an inorganic source.

Ascorbic Acid in Juice

An inverse relationship between ascorbic acid and nitrogen in the juice was found in the Riverside experiments, when all the treatments were considered. There was no such correlation for the Claremont experiments, in which all plots using a moderate quantity of nitrogen nor at Riverside when only those plots using the same amount of nitrogen were considered.

The application of phosphorus tended to reduce the ascorbic acid concentration. The further addition of potassium apparently counteracted this effect. When used alone, potassium slightly increased ascorbic acid concentration in the juice of fruit of the covercropped plots at Riverside. Manure, when used alone, decreased ascorbic acid.

Effects of Covercrops

The growing of winter covercrops at Riverside reduced the concentration of both nitrogen and potassium in the juice, and caused a slight increase in its calcium concentration.

Other effects of covercrops apparently were: *1*, a slight, but not significant, decrease in specific gravity of the whole fruit; *2*, no effect on percentage of juice; *3*, a very slight but significant increase in the pH of the juice; *4*, a barely significant decrease in the percentage of acid in the juice; *5*, a slight decrease in soluble solids; *6*, no effect on the ratio of soluble solids to acid; *7*, a slight increase in the ascorbic acid; and *8*, no effect on the phosphorus in the juice.

Minerals in Juice

The application of nitrogen fertilizer increased the concentration of nitrogen in the juice. Where the application of nitrogen was the same, the nitrogen content in the juice was not changed by the application of phosphorus and/or potassium.

The application of manure significantly decreased the nitrogen in the juice.

The phosphorus content of the juice increased with phosphorus fertilization and decreased with nitrogen application. In plots fertilized with equal amounts of nitrogen the application of phosphorus resulted in a slight increase of phosphorus in the juice. The application of potassium along with phosphorus caused a slight decrease in phosphorus in the juice; the use of potassium alone caused an even larger decrease in phosphorus.

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lyzes. There are, however, commercial dust mixtures available in which little deterioration of the tetraethyl pyrophosphate occurs within a period of several weeks after they are prepared. Only such products should be used, because to approach satisfactory control practically all the aphids in a treated field must be killed.

Effect of DDT

It has been generally recognized that applications of DDT to melons on many occasions have resulted in an increase in the aphid population. However, it is desirable that a program be developed in which DDT can be used because it is so effective against *Diabrotica* beetles and the melon leafhopper, *Empoasca abrupta* De Long. Both of these insects are very destructive to melons and if not controlled may greatly injure the crop. During 1948 and 1949 extensive investigations were conducted and it was found that under some conditions DDT can be applied without resulting in a severe loss from aphids. On numerous occasions the environmental balance was not adversely affected. It is certain, however, that the amount of DDT used should be held to a minimum and treatments should be properly and thoroughly applied so that both the *Diabrotica* beetles and the leafhopper are nearly eliminated from the field. However, in order to guard against complications frequent applications of DDT to control these insects should be avoided. During the early stages of growth a material such as cryolite should be used to control *Diabrotica* beetles. Later when the leafhopper population develops to a level to justify control, an application of DDT can be made. It was found that 30 pounds of a 3% dust or a spray containing approximately two pounds of 50% wettable powder per acre will adequately control the leafhopper as well as any *Diabrotica* beetles present. Such a practice need not result in a serious dislocation of the environmental balance. During the 1949 season insect population trends were followed in a number of fields that received a DDT treatment. Subsequent to treatment in fields at Brentwood, Contra Costa County, and at Woodland, Yolo County, there was an increase in the aphid population, followed rather closely by an increase in the predator population. Although the aphid population showed evidence of becoming destructive the threat failed to develop because of the rapid rise in the predator population. The end result was almost perfect biological control. Of the predators present ladybird beetles appeared to be the most important. They were able to establish themselves in the fields rather shortly after the DDT was applied. For example, at Brentwood a 3% DDT dust was applied on July 25th and yet four weeks later the predator population had risen to a sufficiently high level to clearly indicate that it was going to suppress the aphid population. Another example was encountered at Woodland where a melon field was treated with a DDT spray on July 27th. No aphids were observed in a survey conducted on August 5th, but a survey one week later revealed the beginning of an infestation, which gradually increased until September 2d. At this time there were localized areas of severe infestation, but these spots were heavily populated with predators and the aphid population was practically destroyed within the next 10 days. The above illustrations clearly demonstrate that predators are able to establish themselves in a field within a relatively short time after it has been treated with DDT.

The rapid rate at which the predator population increases under favorable conditions is truly remarkable, and if the host population has reached a fairly high level just before it is suppressed the predators are present in great abundance. However, once the aphid is controlled there is a tendency for a rapid dispersal of the predators, and they largely leave the field. Where it is evident that natural enemies are in a position to control the aphid, applications of insecticides that are likely to destroy the environmental balance should be avoided, if this is at all possible.

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Potassium in juice was increased by the fertilization with potassium.

At Riverside, the application of potassium in the fertilizer caused a significant decrease in the calcium content of the juice. The application of phosphorus also reduced the calcium. When phosphorus and potassium were applied together, the decrease in calcium content of the juice was highly significant. The application of manure likewise reduced the calcium content, and high nitrogen from calcium nitrate failed to increase the calcium content. At Claremont, these treatments caused no significant differences in the calcium concentration in the juice.

Correlations

It was found in the Riverside and Claremont experiments: *1*, that a negative correlation existed between the phosphorus content and the acid content of the juice; *2*, that a positive correlation existed between the potassium content and the total acid content of the juice; *3*, that a positive correlation existed between the phosphorus content of the juice and the percentage of juice of the whole fruit; and *4*, that the ascorbic acid content of the juice was negatively correlated with the concentration of phosphorus in the juice.

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FREEZE

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tively large percentage of the freeze injured fruits. The weather conditions were also such that the concentration of soluble solids in the juice did not become so high and the acids did not get so low as in most years.

Young, immature, freeze-injured citrus fruits make a more nearly complete recovery than mature or nearly mature fruits. Under southern California conditions therefore, Valencia oranges, immature lemons and Marsh grapefruit have a better chance to recover than Navel oranges which are usually mature at the time of the low temperatures.

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The detailed results of this investigation will appear in the near future in the form of a University of California Bulletin.

SUGAR BEET

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night temperatures, as well as day temperatures, must be considered in growing a crop of sugar beets successfully at a high nutrient level.

At harvest the beets in this experiment will be analyzed for their sugar content and perhaps the results of the sugar analyses will be as startling as the differences observed in the growth of the beet plants themselves.

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The Earhart Plant Research Laboratory where this project is being conducted is under the direction of Professor F. W. Went at the California Institute of Technology in Pasadena.